

CLAIMS

1. Medical apparatus comprising:
 - an elongate intervention device being operable to be inserted into a human or animal subject, and
 - at least one force-measuring sensor connected to the intervention device and disposed at at least one location along the intervention device; the at least one force-measuring sensor being arranged to measure 3-D forces acting on the intervention device at the disposed location.
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2. Medical apparatus according to claim 1, wherein a said force-measuring sensor is disposed near or at the insertion end of the intervention device.
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3. Medical apparatus according to claim 1 or claim 2, further comprising a plurality of force-measuring sensors connected to the intervention device and disposed at locations along the intervention device.
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4. Medical apparatus according to claim 3, wherein the plurality of force-measuring sensors are disposed at intervals along the whole or a part of the length of the intervention device.
5. Medical apparatus according to claim 4, wherein the plurality of force-measuring sensors are disposed at uniform intervals.

6. Medical apparatus according to any one of claims 3 to 5, wherein at each location a plurality of coplanar force-measuring sensors is provided.
7. Medical apparatus according to any one of the preceding claims, further comprising at least one deformation sensor connected to the intervention device and disposed at at least one location along the length of the intervention device for measuring the deformation of the intervention device at the disposed location.
8. Medical apparatus according to claim 7, wherein the at least one sensor and the at least one force-measuring sensor are interleaved at intervals with each other along the length direction of the intervention device.
9. Medical apparatus according to claim 8, wherein the sensors are interleaved at uniform intervals.
10. Medical apparatus according to any one of claims 7 to 9, further comprising a plurality of deformation sensors connected to the intervention device and disposed at locations along the length of the intervention device.
11. Medical apparatus according to claim 10, wherein at each location a plurality of coplanar deformation sensors are provided.

12. Medical apparatus according to any one of the preceding claims, wherein the deformation sensors are in the form of fiber optic sensors.
13. Medical apparatus according to any one of the preceding claims, wherein the force-measuring sensors are in the form of haptic sensors.
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14. Medical apparatus according to any one of the preceding claims, wherein the intervention device is a catheter and the sensors are connected to the catheter.
- 10 15. Medical apparatus according to any one of claims 1 to 14, wherein the intervention device is a guide wire for a catheter and the sensors are connected to the guide wire.
16. Medical apparatus comprising
15 an elongate intervention device being operable to be inserted into a human subject or animal subject; and
at least one deformation sensor connected to the intervention device and disposed at at least one location along the length of the intervention device, the
20 at least one deformation sensor being arranged to measure deformation of the intervention device at the disposed location.
17. Medical apparatus according to claim 16, wherein at each location a plurality of coplanar deformation sensors are provided.

18. Medical apparatus according to claim 16 or 17, further comprising a plurality of deformation sensors connected to the intervention device and disposed at locations along the length of the intervention device.
- 5 19. Medical apparatus according to any one of claims 16 or 18, wherein the deformation sensors are in the form of fiber optic sensors.
20. Medical apparatus according to any one of claims 16 to 19, wherein the intervention device is a catheter and the sensors are connected to the catheter.
- 10 21. Medical apparatus according to any one of claims 16 to 20, wherein the intervention device is a guide wire for a catheter and the sensors are connected to the guide wire.
- 15 22. In combination, medical apparatus according to any one of claims 16 to 21, and processing means for determining the shape of the intervention device based on the deformation measurement
- 20 23. A combination according to claim 22, wherein the processing means further comprises means for displaying the shape of the intervention device.
24. Haptic feedback apparatus comprising:
force application means arranged to apply a force to an elongate intervention device, control means arranged to control the force applied to the intervention

device by the force application means, the control means being connected to at least one sensor arranged to sense a remote force on the intervention device and the control means being arranged to calculate the applied force in accordance with the remote force, the applied force being an amplification of the remote force.

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25. Haptic feedback apparatus according to claim 24, wherein the force application means comprises a resilient member arranged to apply the said force to the intervention device.
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26. Haptic feedback apparatus according to claim 25, further comprising a sensor arranged to detect frictional force between the resilient member and the intervention device.
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27. Haptic feedback apparatus according to claim 26, wherein the detected frictional force is used to control the amount of applied force.
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28. Haptic feedback apparatus according to any one of claims 24 to 27, further comprising means for tracking the rotational movement of the intervention device.
29. Haptic feedback apparatus according to any one of claims 24 to 28, further comprising means for tracking the linear movement of the intervention device.

30. Haptic feedback apparatus according to any one of claims 24 to 29, further comprising means for comparing the remote force with a reference force.

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31. Haptic feedback apparatus according to any one of claims 24 to 30, wherein the intervention device is operable to be inserted into a simulated human model.

10 32. Haptic feedback apparatus according to claim 31, wherein the remote force is generated using computer simulation.

15 33. Haptic feedback apparatus according to any one of claims 24 to 32, wherein the intervention device is operable to be inserted into a human subject.

34. Haptic feedback apparatus according to any one of claims 24 to 33, wherein the at least one sensor is disposed near or at a tip of the intervention device.

15 35. Haptic feedback apparatus according to any one of claims 24 to 34, further comprising a plurality of sensors disposed along the length of the intervention device and the control means is connected to each of the plurality of sensors.

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36. In combination, medical apparatus according to any one of claims 1 to 15 and haptic feedback apparatus according to any one of claims 24 to 35.